MINUTES OF THE NASA ENVIRONMENTAL COMPATIBILITY RESEARCH WORKSHOP
HELD MARCH 17 - 19, 1998
AT THE RADISSON HOTEL, ATLANTA, GEORGIA

The following persons attended this workshop.

First NameLast NameCompanyKrishAhujaGeorgia Institute of TechnologyRichardAntcliffNASA LaRCHowardAylesworthAerospace Industries Association Of AmericaJamesBaederUniversity of MarylandDavidBallardGRA, Inc.PeterBattertonNASA LeRC SteveBradfordFAA ASDS-130GeraldBrinesAllison Engine CompanyRaymondBrownDelta AirlinesCarrolBryantTransportation Solutions, IncAdinaCherrySAICKestutisCivinskasNASA LeRCJohn-PaulClarkeMassachusetts Institute of TechnologyThomasConnorFAACarolynCunninghamNatural Resources Defense CouncilRobertCuthbertsonThe Boeing CompanyWalterDesrosierGAMAWilliamDoddsGeneral ElectricJohnDodgeAllied SignalDouglasDwoyerNASA LaRCJamesEricksonFAASueGanderCenter for Clean Air PolicyPhillipGliebeGE AircraftRichardGolaszewskiGRA, Inc.MarkGuynnNASA LaRCDennisHuffNASA LeRCTinaHunterFAARodJagoSAICBetty AnnKaneN.O.I.S.E.RichardLawrenceNASA Goddard Space Flight CenterCindyLeeNASA LaRCJohnLevertonGKN WestlandDianaLiangASD-430DickLinnDFW AirportJamesLittletonFAAMikeLoescherSAIC ConsultantWesleyLordPratt & WhitneyStephenLukachkoMassachusetts Institute of TechnologyGaryMachlesGE Aircraft EnginesTyMarienNASA LaRCWilliamMarxFAADouglasMatthewsPratt & WhitneyEdwardMcQueenFAARichardMiake-LyeAerodyne Research Inc.NicholasMillerHMMHJohnMitchemAllied Signal AerospaceSteveMoranWhite House/OSTPStephenMorfordPratt & WhitneyFrankMurraySAIC ConsultantCindyNewbergEPARobertPearceNASA HQDeborahPeisenSAICAnniePetsonkEnvironmental Defense FundClemmonsPowellNASA LaRCRonaldRayNASA DrydenN.N.ReddyLockheed Martin Aeronautical SystemsLisaReussSAICKarenRobertsonDFW AirportJohnRohdeNASA LeRCCarolRussoNASA LeRCBenSharpWyle LaboratoriesNancySheltonFAABelurShivashankaraBoeingJimSkaleckyFA AGlennSmithNASA HQChuckSmithNASA AmesPaulSodermanNASA AmesDavidStephensNASA LaRCGaryStowellSan Jose International AirportDonaldSutkusBoeingRichardThompsonHMMHIanWaitzMITDon aldWeirAllied Signal EnginesHowardWesokyNASA HQMichael WhiteMitre CorporationWilliamWillshireNASA LaRC

The following represents a synopsis of the discussion at this Workshop as related to the published agenda.

Welcome and Introductions

Mr. Howard Wesoky opened the workshop by welcoming attendees and then presenting the remarks in Attachment A-1.

Frank Murray, the meeting Chairman, was introduced and reiterated Howardís welcome to the participants and stated that he was encouraged by the number of interested parties attending the workshop. He also stated that the different backgrounds, interests, and beliefs prevalent in the audience provided a wonderful opportunity to work together and achieve results which will not only help NASA choose a path for future research but also provide meaningful input on the environmental issues of emissions and noise. He noted, ìToo often we view economic growth and environmental health as being mutually exclusive goals. As a society we need to find ways to accommodate both. Technology can play a key role in finding the pathways that will allow us to grow and have a healthy environment.î He concluded that all of us present today have a stake in finding answers to the environmental problems facing aviation. The workshop goal is to tap our collective experience and knowledge to provide insights into how aviation can continue to grow without having an adverse impact on the environment. Finding such solutions is important to all of us, and your active participation in this effort can provide a positive impact on the environmental issues as they relate to the continued growth of aviation.

Workshop Process

Following these remarks, Mr. Murray then briefly reviewed the Workshop Agenda and process, stating that the panel and speaker presentations would follow immediately after the Keynote Speakerís presentation. He stated that following these presentations and an open discussion, working groups would be established and meet to formulate their plans of action. Further discussion on working group responsibilities would take place later in the Workshop.

Keynote Speakers/Panel discussions/Presentations

Keynote Speaker: Steve Moran, OSTP

The Keynote speaker for the Workshop was Mr. Steve Moran from the Office of Science and Technology Policy (OSTP) in the White House. In terms of background, he was involved in aviation technology and policy at both the national and international level throughout his professional career. His remarks provided the context within which the issues of aviation and environment will be addressed.

Topics discussed by Mr. Moran include the Administrationís policy on aeronautical research and development, the United Nations framework convention on climate change, and the Administrationís policy on climate change. The Administrationís goals are to maintain superiority of US aircraft and engines while improving safety, efficiency and cost effectiveness. At the same time, the goals include ensuring long-term environmental compatibility of the aviation systems. Mr. Moran also reviewed the US policies and 3-stage action plan to achieve these goals. The Kyoto protocol was discussed, as were NASAís goals with respect to environmental compatibility.

Copies of the materials used by Mr. Moran in his presentation are provided as Attachment A-2.

Aviation and the environment: A public interest perspective

Mr. Murray introduced the first panel of speakers that presented the views of several public interest groups regarding the environmental impacts of aviation. This panel included Carolyn Cunningham from the Natural Resources Defense Council (NRDC); Ms. Cunningham also served as the chairperson for this panel. Ms. Cunninghamís presentation was developed primarily from the contents of NRDCís Executive Summary of their report, Flying Off Course. The Executive Summary is included as Attachment A-3 to the minutes, and is available through the NRDC website.
(http://www.nrdc.org/nrdcpro/foc/aairexsu.html)

Following Ms. Cunningham, Ms. Sue Gander from the Center on Clean Air Policy (CCAP) discussed the concerns regarding the emissions of aircraft in light of the recent growth of all types of aviation and the forecasts for continued growth in the future. Of specific concern are the health impacts and the fact that approximately 70 million people live in areas that exceed current ozone standards. The ozone problem poses major challenges to state and local officials. It is recognized that aviation is a small contributor, but the problem will increase in proportion to the growth of aviation.

Ms. Annie Petsonk of the Environmental Defense Fund (EDF) followed and covered a number of environmental areas. In particular, she discussed the Kyoto Conference on Climate Change and the current uncertainty as to how this would be translated to the aviation industry. The need to resolve issues such as national emissions goals and the treatment of international flights was raised. She also noted the wide interest in using market mechanisms as a means of banking and trading emission reductions to meet the Kyoto goals.

Completing the Public Interest Panel, Betty Kane of the National Organization to Insure a Sound Environment (N. O. I. S. E.), discussed the problems associated with noise around airports as traffic volumes increase and airports expand the number of runways to accommodate this traffic. She noted that while some progress has been made we still have a long way to go. Additional research is needed in both the noise and emission areas. Human responses to noise needs to be investigated to determine whether noise causes detrimental effects other than sleep loss. Research on insulation and noise barriers also needs to be conducted. Short Takeoff and Landing (STOL) aircraft, quieter engines, and steep-angled approaches are other areas requiring additional research.

Aviation and the Environment: An Industry Perspective.

The second panel was composed of members from the aviation community. Mr. Howard Aylesworth, of Aerospace Industries Association of America (AIAA) chaired this panel. Mr. Aylesworthís remarks noted the advances that the industry had made over the past several decades to improve their performance vis-‡-vis the environment. He noted that it takes considerable investment in time and resources to introduce basic changes to aircraft designs or engines. These requirements mean that the industry cannot instantly respond to new environmental concerns. He also noted that aviation is the most highly regulated industry in the world.

Following those remarks, Mr. John Leverton, a helicopter consultant, discussed the peculiar problems of helicopters especially in relation to concerns about noise. He mentioned that virtual noise is much worse than real noise in regard to rotorcraft. Mr. Leverton stated that additional research is needed on rotorcraft noise abatement procedures and that current procedures force helicopters into a noisy flight mode.

Mr. Ray Brown, of Delta Airlines, discussed the airline operatorís perspective and their efforts to keep their fleet of airplanes abreast of the latest improvements in terms of

environmental performance in a highly competitive industry. He noted that Delta and other airlines have implemented fuel conservation methods and as a result, fuel efficiency is steadily improving. Since fuel is Deltaís second highest expense, reduced usage is a continuing goal. Achieving this goal will also result in lower aircraft emissions. It was also noted that the implementation of a new CNS/ATM system would help in both respects.

Mr. Belur Shivashankara from Boeing discussed the various airframe design and engine parameters that affect the noise levels of aircraft during various stages of the airplane operations, as well as the environmental performance of newer aircraft entering into service. He noted that there are 3 major issues associated with aircraft noise: engine and airframe noise reduction, operating procedures, and land-use planning. He pointed out that the following are all emerging issues: 1) costly and time consuming technology implementation, 2) cost effective noise solutions required for breakthrough technologies and 3) noise exposure to service personnel and the crew. He concluded that a balanced approach is needed to achieve desired results.

Finally, Steve Morford, of Pratt and Whitney, covered aircraft engine performance, continuing requirements for safety and certification requirements of new engine types. He mentioned that the issue is not engine technology but rather implementation and economics.

Aviation and the environment: An airport operator perspective:

The final discussion panel was composed of Mr. Dick Linn from the Dallas Fort Worth Airport and Ben Sharpe of Wyle Laboratories. (Ms. Carrol Bryant of Transportation Solutions, who was scheduled to make a presentation at this time, was unable to attend.) Mr. Dick Linn spoke extemporaneously in regard to an airport operatorís perspective of environmental issues with particular emphasis on the noise issue, giving an account of the practical problems in trying to address the complaints about noise. He related that his involvement first began when he was employed by American Airlines as an aeronautical engineer for 30 years. Noise impacts first began to be an issue with the fielding of the 727. NASAís involvement began in the early 60ís and progress on noise reduction particularly related to engines began to take effect. As noise levels decreased with the advent of the new, quieter engines however, people began to chase the reducing contour lines and new housing developments were being built closer to the airports.

NASAís Advanced Subsonic Transport (AST) program should result in maybe a 10 dB reduction in noise, but the fear is that additional chasing of the contour line will occur. If a reduction to 55 LDN is required, the airlines should not have to bear the brunt of this extremely expensive requirement. Costs should be shared. Where airports have expanded and impacted local populace, mitigation programs have been implemented and financed by airport authorities.

Mr. Linn went on to cite specific examples of how airports were being impacted by the environmental concerns about noise. He also spoke briefly relating to airport localized emission problems. The overall message of Mr. Linnís presentation was that industry to this point has financed this entire effort and now it is time for the communities to help support this effort.

Mr. Linn is preparing a paper to express his thoughts on the subject, and it will be ready for dissemination for the Cleveland Meeting.

Mr. Sharpe followed with a discussion of a study that is being undertaken by his organization. He emphasized the number of variables that are at play in correlating

measurable noise levels with subjective opinions as to acceptable and unacceptable noise levels. Mr. Sharpeís presentation is included as Attachment A-4.

Working Group Process

The Chairman, Mr. Murray, opened this Agenda Item by referring to the Working Group Matrix provided as a handout. He explained that the Framework and the Technology Groups would meet in separate rooms and begin to formulate plans of action for their individual areas of responsibilities. He stressed that as a ìrule of engagement,î participants should not assume what others would say, but rather listen and try to understand what was meant and to ask questions if understanding was lacking. He encouraged everyone to pursue this effort with an open mind with the intent of providing meaningful inputs that can have a positive effect on the overall outcome. Following these words, the two Groups separated into their individual sessions.

VI Establish Working Groups

The two groups were asked to answer the following questions during their deliberations.

Framework: What are the environmental issues that are likely to impose fundamental limitations on aviationís growth?
Chairperson, Annie Petsonk and Facilitator, Michael Loescher led the efforts of the Framework Group.

Technology: What are the technical challenges faced in eliminating the fundamental limitations to aviationís growth?

After a very brief discussion, it was decided that this group should be further broken down into Noise and Emissions subgroups. Dr. Ahuja was designated chairperson for the noise subgroup and Dr. Waitz led the emissions subgroup.

In the Noise Subgroup, Dr. Ahuja used the brainstorming technique to identify issues, which could impact the achievement of future aviation growth. During this session over 60 issues were identified. These issues were used for the preliminary subgroup report during the next dayís session. They are included as Attachment A-5 to the minutes.

In the Emissions Subgroup, Dr. Waitz also used the brainstorming technique to identify issues. These issues were broken into 3 groups: (F) need framework input, (T) pure technology, and (N) noise/emission discussion. These issues were used for the preliminary subgroup report during the next dayís session. These are included as Attachment A-6 to these minutes.

The framework group had difficulty getting focused on its task. The use of the term framework was a source of some confusion; because of this confusion, technology issues kept creeping back into the group discussions. There was also a tendency to move back and forth between examples in the noise area and examples in the emissions area. This added to the difficulty of keeping the group focussed on the task at hand.

Reconvene plenary

On the opening session of the second day of the workshop, the leaders of the respective breakout groups reported back to the plenary and discussed the general tenor of their discussions and the direction that was proposed for the coming sessions. They also noted any problems or issues that their particular breakout group may have encountered. Where appropriate they asked for comments or redirection from the plenary group.

Framework Working Group feedback

The Framework breakout group had only a few conclusions to put on the table by the next morning. Due to the fact that broad framework issues are by definition less specific and more nebulous, the group struggled to get started. They did agree that aviation growth should not be limited if it could be accomplished without an increased impact on the environment.

B. Technology Working Group feedback.

Drs. Ahuja and Waitz reviewed the progress of their individual subgroups from the previous afternoonís sessions. Dr. Ahuja briefly discussed the issues identified and reported that the Noise Subgroup would be refining this list and placing them into major issue categories. Also he mentioned that some framework issues were identified and these would be passed to the Framework Group. Dr. Waitz reviewed his subgroupís activities the results are in Attachment A-7.

Following the presentations, the working groups reconvened.

Reconvene Working Groups

Following the reports to the plenary, the working groups reconvened to address the previous dayís findings and the issues identified for discussion in the Workshop Agenda. The following represents a synopsis of Wednesdayís activities.

In the Technology Noise Breakout Group, the participants wrestled with the problem of the subjective nature of what is an acceptable level of noise and what is not acceptable. They noted that factors such as background noise, time of day, and frequency, all affect ìacceptabilityî. The use of DLN was felt to be overly simplistic and did not assure ìacceptabilityî.

The Noise Subgroup discussed the issues developed during the previous dayís session, with the intent of placing them into 9 major issue areas. These major issue areas with their sub-issues are attached to these minutes as the ìTechnology Report.î

In its discussions about emissions, the Technology Breakout Group discussed the trade-offs in the emissions area. How emphasis on reducing one type of emission (e.g. NOx) might have adverse effects on other emissions such as CO2 via decreased fuel efficiency. A related issue was local NOx versus total NOx and CO2 and the trade-offs between performance in the take-off-landing cycle versus cruise performance, and so forth. They did agree that it was important to get a better base of scientific understanding to more fully comprehend the implications of various trade-offs.

During the Emissions Subgroup deliberations, the working groups addressed the morningís plenary comments; determined information requirements; prepared a report for presentation at the concluding session of the workshop; and finally, defined actions for

SAIC, NASA, and the Working Group. These action items are listed in Attachment A-8 of these minutes.

IX Reconvene plenary for Working Group Reports

The following reports represent a compilation of the Emissions and Noise (de facto) Working Groups. The restructuring of the Working Group reports into two separate categories of Emissions and Noise, reflected the participantsí view that the issue categories (emissions and noise) were a more logical form of organization. This allowed them to make better use of their expertise and interests than did the original organization into Framework and Technology issues.

Emissions Report

The Emissions Working Group formulated four questions to help focus their discussions and organize their findings. These were:
What should high level NASA program objectives be? (e.g., reduce climate change effects)
What should NASA programs focus on? (CO2 or other effluents)
What are the appropriate metrics for the scope, magnitude and timing of the reductions?
What other key technical questions need to be addressed?

Using these questions, the Emissions Working Group developed the matrix provided below to organize their information and present their findings. The findings were further identified as to their relevance to three different classes, namely, 1) Ozone Layer Protection; 2) Local Air Quality, and 3) Global Climate Change. This information is contained in the tables below. The group identified a number of overarching questions and issues that were important to address. Finally, there is a list of questions that should be considered in future meetings of the Emissions Workgroup.

Ozone Layer ProtectionLocal Air QualityGlobal Climate Change
(CO2 and all other GCC agents)

What should high level NASA Program Objectives be?Provide technology so aircraft do not have a significant impact on ozone layer
No change in ozone layer from today
Return ozone layer to pre-Montreal protocol levels by 2030Develop technology that enable aircraft to contribute to improvements in LAQ independent of growth of air traffic
Develop technology that helps improve LAQ
Develop technology that reduces current LAQ impact of a/c
Reduce NOX & VOC without adversely affecting other LAQ emittantsHelp US achieve its GCC goals
Develop technology that ensures a/c are compatible with GCC goals
Develop technology that helps US industry in negotiation and trading in addressing GCC issues
Research programs that assists policy makers to determine what technologies are feasible to address: GCC US as a technological leader in marketing these technologies worldwide
Ozone Layer ProtectionLocal Air QualityGlobal Climate Change
(CO2 and all other GCC agents)

What should NASA Programsí Focus be?NOX
Sulfur/Aerosols
Ozone chemistry and transport
Atmospheric models & assessmentsLTO
NOX & VOC
CO
ToxinsReduce fossil fuels burned
Continued scientific assessments of aviationís affects on GCC
Look at relative research, focus on CO2, NOX, clouds to ensure unintentional impacts are avoided
Look at relative importance of CO2, NOX, clouds on GCC
Try to reduce fossil fuel burned and not increase other important emitters
Ozone Layer ProtectionLocal Air QualityGlobal Climate Change
(CO2 and all other GCC agents)

Scope/
Magnitude/
Timing of reductionsëPracticalí lower limits achievable
Projected no impact from climate models
Look at level of emittants resultant impact on health to determine ëacceptableí realm
Look at range of fleet models - subsonics, supersonics
Define appropriate metrics
2030 to return ozone layer to pre-CFC stateTiming set by rate & growth
What can technology do?
Reduce NOX by 35% by 2003 ñ local goals further reduction for 2010Shorter term: reduce fossil fuel burned
Longer term: more aggressive reduction levels that might be beyond feasible fossil fuel burned reduction
Strongly link to Kyoto Protocol & air traffic growth rate
International influence need to be assessed: push by Europe/Asia
Strong links to Kyoto will accelerate timingóneed to look at more clearly
Quantum leaps needed
Magnitude and timing are strongly linked

As much reduction as possible as soon as possible ñ NASA should assess this for feasibility
Ozone Layer ProtectionLocal Air QualityGlobal Climate Change
(CO2 and all other GCC agents)Key Technological IssuesMinimize cruise NOX to lowest practical level (e.g. considering cost, safety, other environmental impacts)
Low/zero sulfur fuels development that is practical for worldwide aircraft use
To incorporate potential environmental (ozone) impact into flight planning

Better scientific understanding & ability to model is desired (Framework science issue)
Minimize landing/take-off NOX, VOCs to lowest practical level
Flexible in response to temporal & local variations in air quality
Minimize effluents during ground operations
Develop aircraft and operations to allow for growth while still responding to proposed framework challenges
Action Item: Framework: Should we worry about soot, CO, SO2?Identify fundamental (practical & feasible) limits for conventional hydrocarbon fuels
aero/structural/ops
operation
For practical aircraft system, various subclasses of aircraft:
large transport, rotor, blimps
Identifying technical feasibility of practical non-conventional fueled combustion-based aviation
Look at new holistic problems that might arise
Given decreased CO2 and increased traffic, define technology mix as a function of time

Additional (Over-arching) Questions/Issues:

Need to look at trade-offs among emittants and environmental impacts
Need to look at affordability and economic feasibility/investment level & timing for all technology developed
Look at a range of fleet models ñ subsonic, supersonic.
Need to define appropriate metrics
Useful to explore further what levels/impacts of emittants on environment are ëacceptableí.
Donít want to limit aviation growth IF we can address environmental issues.
Need to look at longer-term solutions/technologies beyond current fossil fuel systems.
Faster development & certification times:
development
retrofit challenges
fleet penetration
while economically feasible, practical, manufacturable, durable, etc.
Coupled constraints
trades
System-level design & analysis tools
New laboratories, facilities, expertise, as scope of solutions broaden.
Closer integration of technologies/regulators/environmental NGO
New technologies and procedures must be compatible with decreased noise objectives and solutions

Questions & Preparations for Future Workshops: (Local Air Quality)

1. EPA study to determine role of airport in local air quality, additional information from EPA website.
2. Re-visit ëFlying Off Courseí.
3. ICAO Working Group 3 references.
4. Landing/take-off calculations showing relative contribution of various aircraft and flight segments
5. Estimate of max achievable from ops with current a/c fleet.
6. FAA Advisory Circular on emissions
7. Can we provide IPCC Tech Chapter?
8. NASA Assessments
9. Homework assignments prior to workshop. (Position papers)

Questions & Preparations for Future Workshops: (Ozone Layer Protection)

1. Change achievable for state-of-the-art LO-NOX combustors for aircraft
2. Articulation of current national strategy/goals

EPA strategic ozone page

3. Papers on low sulfur and alternative fuels

Questions & Preparations for Future Workshops: (Global Climate Change)

1. Mitre report - fuel savings from CNS/ATM exercise
2. Emission distribution modelóto look at large levels
3. NASA studyótotal world fleet CO2 emissions
4. Cost/benefit information lackingócan anyone help?
5. Maximum achievables system study ñ NASA
6. Better articulation of Kyoto protocol goals

B. Noise Report:

There were several overriding views expressed by the working group participants. They included the opinion put forth that noise can restrict the growth of aviation if the level of complaints from communities around airports is not addressed. There was also general recognition that everyone involved has a part to play and that everyone needs to pay to achieve the goals put forth. In addition, there was general agreement that the acceptable levels of noise [and emissions] have not yet been determined.

The Report of the Noise Working Group was organized into key issues. For each of the issues a number of key factors or questions were identified that are important to understanding and consideration of the specific issue. For example, the first issue ìClear Definition of Noise Goalsî included factors such as-- Reasonable Attainable Goals; Is there a physical noise floor? Or Ramp noise reduction; etc. Subsequently the Impacts of each issue were analyzed, and finally, the third section asked the question, ìHow do these fit within NASA goals?î Each of the Issues identified by the working group is analyzed using this structure.

Subsequently the working group ranked each of the issues in terms of its priority among the group. This ranking provides an indication of the priorities of the group for discussion at the second workshop. For example, the impact or population growth and the impact of air traffic growth are listed as two of the more relevant issues. The final section of the report contains some preliminary comments on the Issues identified in the issue matrix.

Major Noise Issues 1. Clear Definition of Noise Goals 2. Metrics: Ability to Predict Influence of Noise on People 3. Certification/Regulations 4. Adequate Research Infrastructure Capabilities 5. Implementation Issues 6. Cost-Benefit of Achieving NASA's Goals/Economics 7. Strategies 8. Framework
1. Clear Definition of Noise Goals Issues A. Definition of 3 Pillar Noise Reduction Goals B. Reasonable attainable goals C. Is there a physical noise floor? D. Ramp noise reduction E. Cabin noise reduction F. Identifying technology baseline (to measure goals against) G. Definition of constraints in achieving goals H. Vehicle classification (HSCT, AST, rotorcraft, etc.) I. Measure of success J. Mission K. Low background noise of the future Impact A. Step change (paradigm shift) B. Affect strategy C. Affect final product D. Affect noise metrics E. Affect product mix F. Affect how money is applied G. Affect perspective (e.g., community) How Do They Fit with NASA's Goals? A. Adds clarity
2. Metrics: Ability to Predict Influence of Noise on People
Issues A. Vehicle classification B. Single event vs. average C. Noise character D. Sound quality Impact A. Affects focus of research to meet metric B. People will hear aircraft but won't be annoyed by sounds C. Ability to measure benefit of noise control tech D. Incorrect metric will produce misguided research/solution (Dick L. of DFW, disagreed with above statement) How Do They Fit with NASA's Goals A. Quantify our goals and define strategies3. Certification/Regulations Issues A. Noise certification limits in the future B. Local rules C. Certification process Impact A. Current certification may not appease public (Should it?) B. Affect cost to businesses C. Technology guides future rules and vice versa D. Certification provides tool to judge progress in technology E. Provide enabling capabilities to achieve NASA goals How Do They Fit with NASA's Goals A. Reduce the need for proliferation of local rules4. Adequate Research Infrastructure Capabilities Issue A. Methods to accelerate technology development B. Improved/credible noise prediction tools C. A step-change technology D. Sonic boom E. Major new research facility requirements F. Improved analytical and expert modeling techniques G. Facility background noise (will have to be low) H. Scarcity of noise experts I. Advanced instrumentation (sensor technology) J. Test facilities Impact A. If we're weak, we won't achieve goal B. Will lead to more competitive vehicle C. Affects decision of choices D. Provides flexibility and innovation E. Improves diagnostic capability F. Reduces cost, time and risk G. Accelerates technology development How Do They Fit with NASA's Goals A. Will provide enabling capability to achieve NASA goals
5. Implementation Issues Issue A. Retrofitability of solutions B. Installation issues Ultra High Bi-Pass Ratio (UHBPR) engines (BP ratios>10) C. Time from research to implementation D. Aircraft /engine integration (system approach) E. Trade-off between noise and other performance criteria F. Producability of noise reduction methods Impact A. May take time and cost to do it-- Implementation cost maybe an order of magnitude more than that for noise reduction B. May lead to premature retirement of current aircraft C. More options for noise reduction (systems approach) D. Transition technology faster

(systems approach) E. Effectiveness of integration will affect manufacturer's acceptance adoption F. May impact National Airspace System (novel concepts may impact issue) G. Reduced Cost of Air Travel (RCAT) H. Much more complex issue I. Retrofits can accelerate total fleet noise reduction J. Will require multi-disciplinary team How Do They Fit with NASA's Goals? A. Direct effect on timing into fleet B. Prioritizes technology
6. Cost-Benefit of Achieving NASA's Goals/Economics Issue A. Airline economic growth B. Affordability C. Cost of noise reduction D. Cost of research Impact A. If too costly, no implementation B. Will require seed money (investment) C. Airlines will grow D. Reduce blocktime E. 24-hr/day operation of the fleet F. Increase capacity G. Affects Reliability & Maintainability H. Reduce cost of land-use measures I. Improved aerodynamic performance How Do They Fit with NASA's Goals? A. Benefit to community and aviation industry7. Strategies Issue A. Unconventional airframes and engines B. Low frequency noise for vibration problems C. Noise as an airframe design noise parameter D. Source noise reduction E. Innovative acoustics liners F. Balance between base and focus program G. Flight operations H. Advanced active control I. Resource allocations: engine vs. airframe J. Broad systems approach K. Fixed design vs. adaptable design L. Gap assessment M. Re-engineered ATM to include noise issues N. Noise as a design driver or controller Impact A. No specific impacts were identified. How Do They Fit with NASA's Goals? A. No inputs were specified.8. Framework Issue A. Source control vs. residential control (7) B. Noise reduction vs. safety (2) C. Education of public (7) D. Who should pay? (65 or 55 LDN) (7) E. Non-acoustics (virtual) noise F. Impact of population growth (8) G. Air traffic growth (8) H. Public response methodology (1) Impact A. No impacts were identified.
How do They Fit NASA's Goals? A. See following Framework table (next page)

EXPECTATIONS FOR WORKSHOP II

Identify

Step Changes
Technologies to Achieve Goals
Benefits & Risks for All Interested/Affected Parties
Technological Barriers

Tasks

Run Scenarios Paper Airplanes to get some sense of 55 dB Contours on Airport
Large Airport
Medium Airport

C. Framework Report

The following table represents the Framework Report at the plenary session. Ms. Petsonk and Mr. Aylesworth briefed the contents and concept of this report at the plenary.

Community NoiseSourceUse of
SourceWhoNASA ObjectiveProtect community
welfareand health with adequatemargin of
safetyNASA ProgramReduce Perceived NoiseShrink Noise
footprint SCENARIOSNationwide or Focus by 10 dB 10 yrs/20 dB 20 yrswithin
A/P boundary realisticWorldwide range use to test 10-20 dB
bring to communitiesScope Magnitude Examine whether
1055dbTimingEPNdB + 20 dB is sufficientgiven growth/AP
constraintsOther Questions1) Fleet competition & turn-
over2) Land-use3) Flight Operations4) Mitigation

Rapporteurs ëimpressionsî

Mr. Murray stated that in coordination with Mr. Wesoky it was decided that a more youthful impression of the Workshop happenings would be presented under this Agenda Item, rather the more traditional rapporteur summary. Cindy Newberg and Don Sutkus were asked to be the ìRapporteursî and they generously accepted this tasking. The following represents their impressions of the workshop.

Impressions

Process

Pros Deltas

Alphabetical seating
More details than just an agenda would have been useful (short desired outcomes)
No identifiers on the name tags -- removes predispositions (even while we quickly learned where we were from)
Have the facilitators interview a range of stakeholders in advance to give them a sense of the issues to provide a rounded vision
Efficiency of recording

General meeting moved smoothly

Number of participants in meeting seemed correct

Length of meeting seemed correct

Ability to brainstorm*
Need to recognize when to switch gears, hold sidebar discussions, to redirect/refocus the group*

Substance

Change in approach: from single point and single aircraft/engine designs to considering total impacts and multiple regimes (e.g., LTO NOx and Cruise NOx)

The term ìframeworkî was difficult to assimilate ñ seems to be policy framework but was that it? Everyone understood what ìtechnologyî meant (thought there were questions regarding whether it was limited aircraft technology).

Wide spectrum of participants:
the organizations that were represented
the background of the individual participants
yet we still lack certain key stakeholders (e.g. airlines and state/local representation)

Sensed frustration from those that have either reached an impasse or may see limits in what can be achieved

Saw a new degree of cooperation

Witnessed unlikely partnerships

Different terms and metrics to measure the same overall impacts demonstrated the diversity of the group and lack synergy

There was agreement:

on a range of environmental impacts (stratospheric ozone protection, climate change, local air quality) that need to be considered in NASAís research program
that generation of technologies to reduce emissions is critical

that future aviation growth need not be constrained if technological solutions can be identified

need to consider what the maximum achievable technological limits are to ensure that we are considering all paths

The Way Forward - Frank Murray, Howard Wesoky

Mr. Murray thanked the chairpersons from the Working Groups for their outstanding efforts during the Workshop. He then related the following Eric Hoffer quote: ìWe often fail to realize how much we are influenced by those we argue with. They force us to reassess and rethink our preconceived assumptions and positions.î Mr. Murrayís perception was that the participants in the Working Groups really listened to each other and considered the various viewpoints. He thought that the Workshop provided an excellent start for the follow-on efforts and identified future directions to be addressed at the next two workshops. Following these brief remarks he turned the meeting over to the NASA sponsor, Mr. Howard Wesoky.

Mr. Wesoky thanked Frank for his excellent chairmanship and reiterated that he also thought that the last 2 Ω days had been very productive in leading the way for future discussions and ultimately identifying future directions for NASA. He specifically thanked all presenters by name and mentioned that the term public interest organizations would be changed to NGO (non-government organizations). He felt that this change would more properly identify the organizations participating in the Workshops because their interests went beyond just the public interest aspects. Howard mentioned that the next workshop would take place May 19 through 21 in Cleveland and that the third workshop would be in the San Francisco area July 7 through 9. Mr. Wesoky also reviewed the objectives and goals of the workshops and this viewgraph is attached to these minutes as ìWorkshop Goals.î Howard also stated that an attempt would be undertaken to include more operators in the next workshops. Several of the participants had mentioned that this was a lacking in the attendance make up of this workshop and their input was needed. Following these remarks, Mr. Wesoky thanked all participants and expressed the hope to see all again at the Cleveland meeting.

Mr. Wesoky adjourned the meeting.

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List of Attachments:
Attachments A-1 Introduction Speech-Howard Wesoky
Attachment A-2 Keynote Speaker Speech-Steve Moran
Attachment A-3 Flying Off Course
Attachment A-4 Airport View
Attachment A-5 Dr. Waitzís Preliminary Subgroup report (Emissions Subgroup)

Attachment A-6 Dr. Ahujaís Preliminary Subgroup report (Noise Subgroup)
Attachment A-7 Preliminary Subgroup report of the (Emissions/Framework Group)
Attachment A-8 Action Items
Attachment A-9 The NASA Flow Chart prepared for Workshop #1 providing the anticipated progression
of the workshops and their objectives. This was to be revised as the workshops
proceeded.
Attachment A-10 The Agenda prepared for Workshop #1.